DV Coding: How it Works with IEEE-1394

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-David Simpson

DV Coding: How it works with IEEE-1394

Presented July 29, 1997

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What is DV?

* DV is a compressed digital video and audio recording standard
* DVC is an abbreviation for Digital Video Cassette
* MiniDV is a small DV consumer cassette.
* DV is endorsed by over 50 major manufacturers.
* It is not DVD!!!

What are the tape specs?

* 6.35 mm (1/4") magnetic tape
* MiniDV cassettes (used in digital camcorders) hold up to 60 minutes of audio/video
* Standard DV cassettes (Sony calls DVCAM) hold up to 180 minutes of audio/video
* 60 minute MiniDV cassette holds almost 13 gigabytes of digital data!
* 180 minute DV cassette holds almost 39 gigabytes of digital data!
* Effective data rate is 3.6 MB/sec continuous

Compressed Video Specs

* Compresses a 720 x 480 4:1:1 YUV image to 103,950 bytes (ratio 4.9 : 1)
* Intra-frame DCT based compression
* Ideal for video editing solutions
* Operates at 30 frames per second
* Effective video transmission rate is 3.12 MB/sec

What does DV have to do with IEEE-1394?

* The hot new digital camcorders use IEEE-1394 to transport DV data

How do I get DV data into my computer?

It is a two step process.

* Capture the DV Data

* Decode the DV Data

Capturing DV Data

* Most 1394 digital camcorders broadcast DV data on isochronous channel 63
* Set tag bit to 01 when you listen on Isochronous channel 63

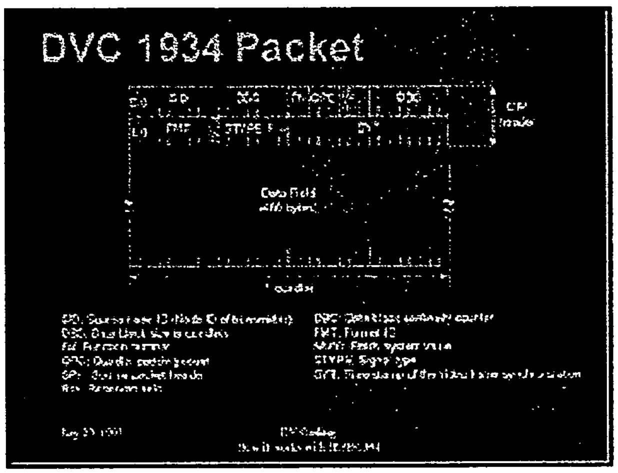
> This usually results in a 'channel' specification of 127 with most Windows 95 IEEE-1394 APIs

* DV data packets are 488 bytes long

8 bytes of CIP header and
480 bytes of DV data

* You must look for the start of a video frame as these 488 byte packets come across the 1394 bus

We look for the 16-bit value 0x1F07 at byte offset 0x08 to determine if we have the first packet of a video frame



* Once you have start of frame you must collect the next 250 valid packets of data to have a complete DV frame
* Every 15th packet is a null packet and should be discarded

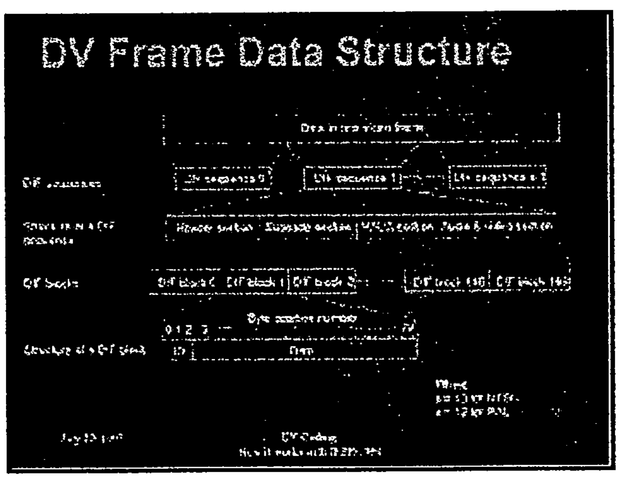
Adaptec and TI handle null packets with their Windows 95 API differently so care must be taken here!

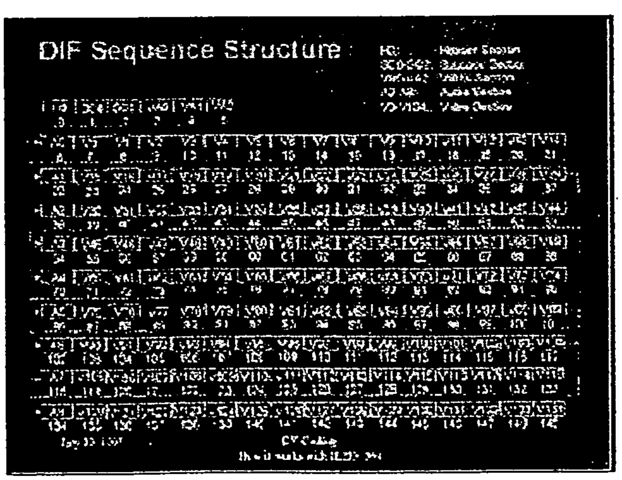
* Once you have 250 valid packets of data in a buffer you must cycle through the packets and discard the CIP headers
* If all went well, you should have a buffer with a 120,000 byte DV frame in it!

Decoding DV Data

* A NTSC DV frame (720 x 480) is divided into 10 DIF (data in frame) sequences each 12,000 bytes long
* One DIF sequence contains five super blocks of video pixel data
* There are 150 DIF blocks of 80 bytes each in each DIF sequence

    135 DIF blocks are used for video information
    9 DIF blocks are used for audio information
    6 DIF blocks are used for Header, Subcode and Video Auxiliary (VAUX) information





Decoding DV Data (continued)

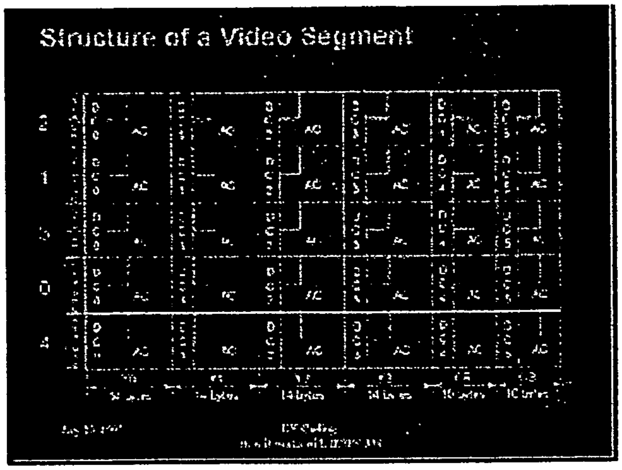
* DV video frames are organized into 270 individual video segments

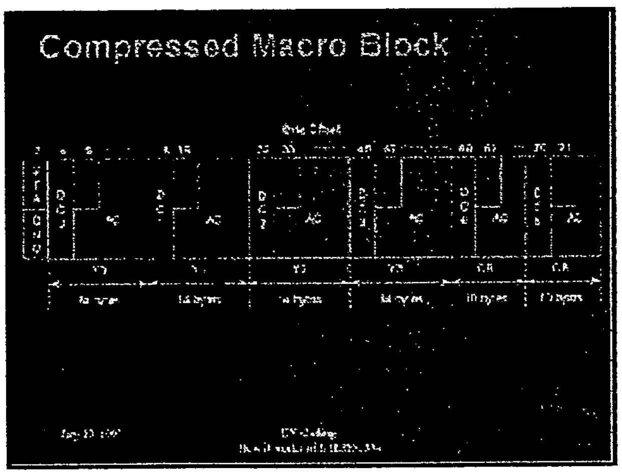
  27 video segments per DIF sequence

* A video segment is made up of 5 compressed macro blocks

  A macro block is 80 bytes long

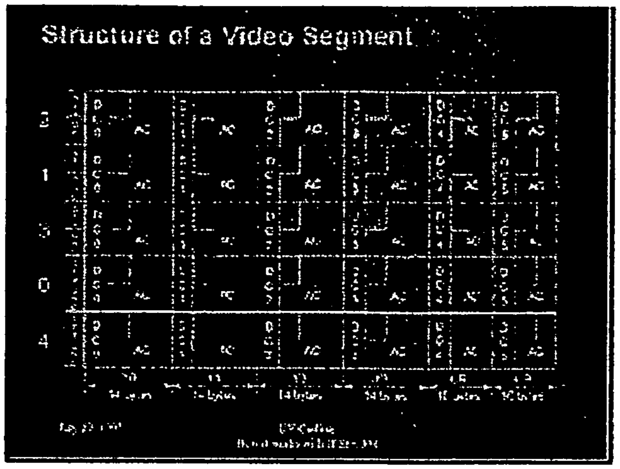
    3 bytes for DIF block ID information
    14 bytes each for Y0, Y1, Y2 and Y3
    10 bytes each for CR and CB
    1 byte for the quantization number (QNO) and block status (STA)
    * Each macro block represents a 32 x 8 pixel region taken from each of five 'columns' of the video frame

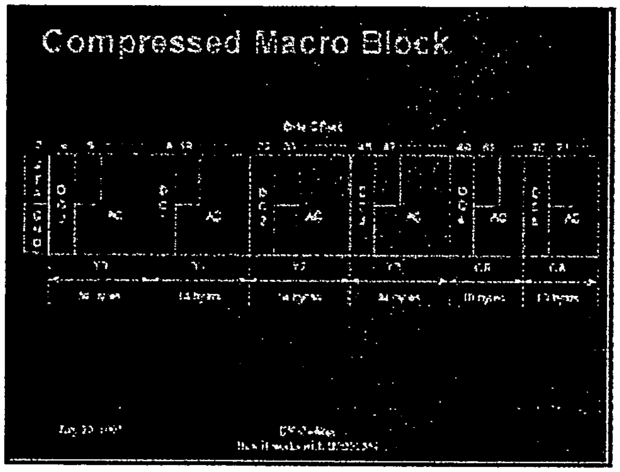




Super blocks

* Super blocks are a logical organization of 27 macro blocks
* There are 50 super blocks in a NTSC DV video frame
* A group of 5 super blocks (1 from each super block column) make up one DIF sequence





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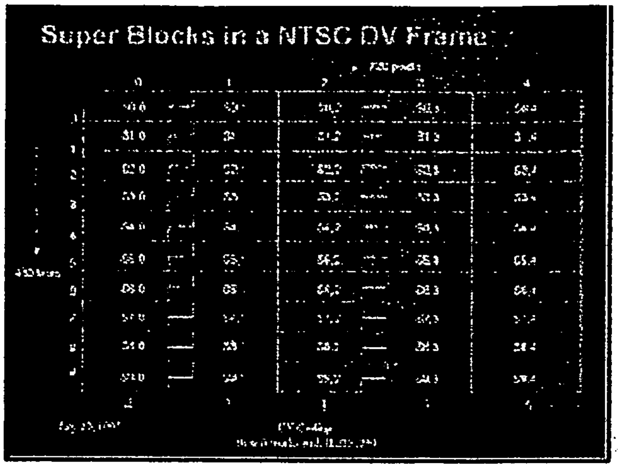
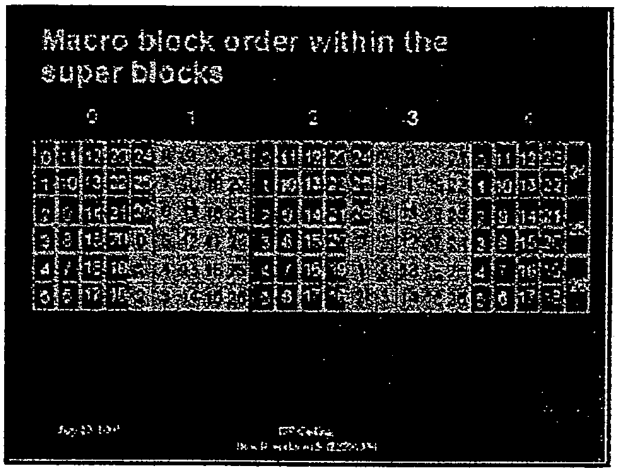
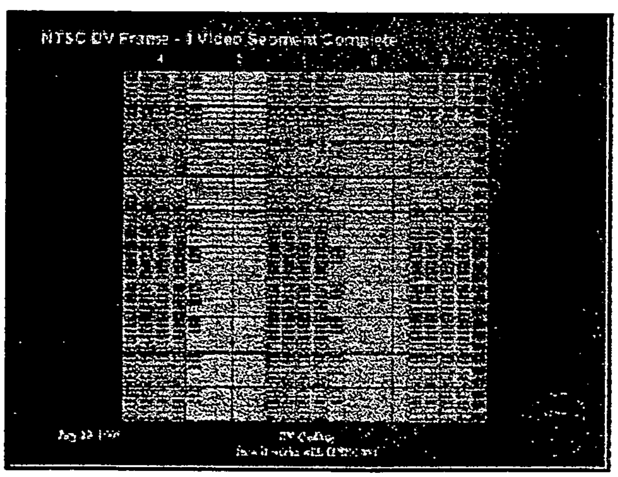
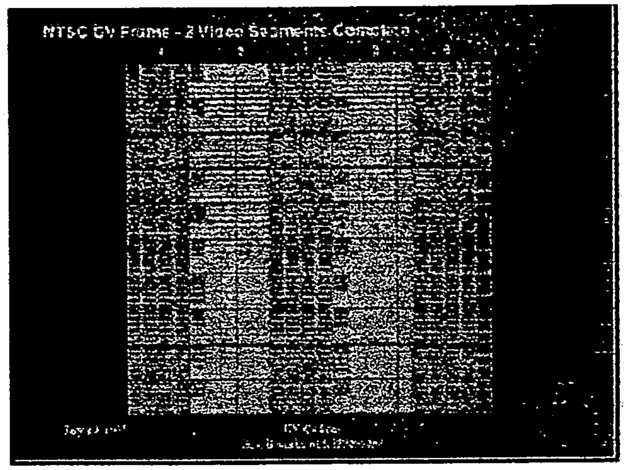
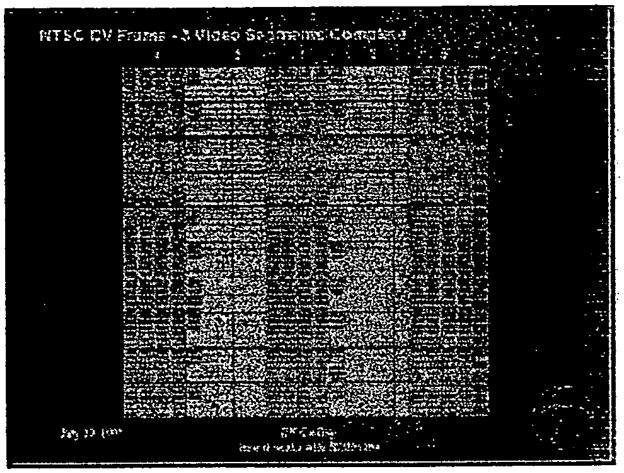


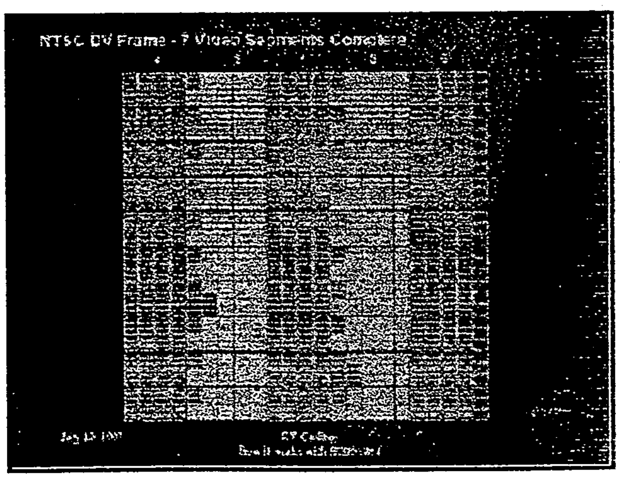


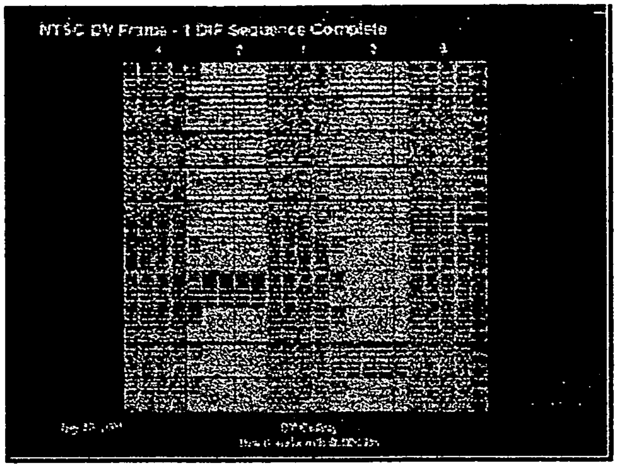
The building of a NTSC DV frame

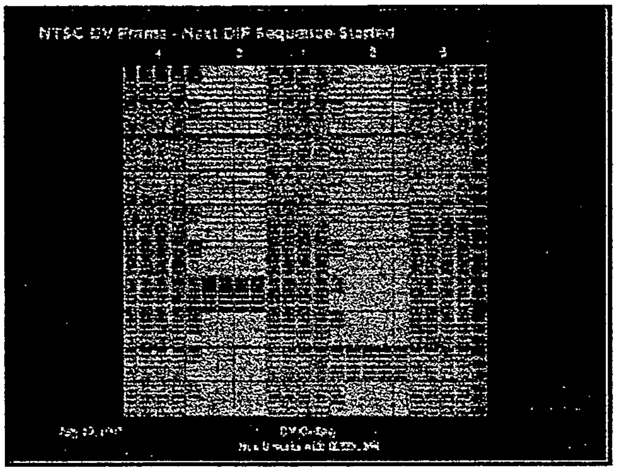



NTSC DV Frame - 2 Video Segments Complete


NTSC DV Frame - 3 Video Segments Complete


NTSC DV Frame - 7 Video Segments Complete





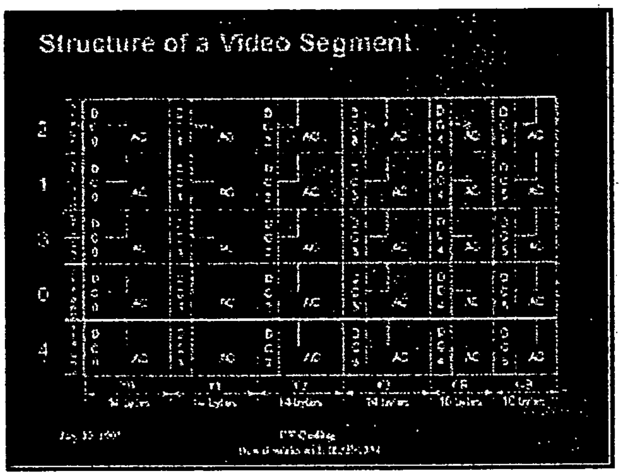
Decoding DV Data (continued)

* Decoding a video segment (a group of 5 related compressed macro blocks)

    Extract AC coefficients via a three pass variable length decoding algorithm

        Pass 1: decode VLC AC coefficients for Y0, Y1, Y2, Y3, CR and CB within a macro block
        Pass 2: decode overflowed VLC AC coefficients within a macro block

Pass 3: decode overflowed VLC AC coefficients within a video segment



Decoding DV Data (continued)

* Once you have AC coefficients:

Inverse quantization
Zigzag coefficient output ordering
Inverse weighting
Inverse Discrete Cosine Transform (DCT) either 8-8 or 2-4-8
2-4-8 is used when there is a lot of detail in the pixel group.
Store the pixel values in their proper location in the video frame

* Every 3 video segments you must be sure to skip the audio DIF block
* Every 27 video segments you must be sure to skip the header, subcode and VAUX DIF blocks (6 total)
* Do the previous video segment decoding sequence 270 times and you have a YUV 4:1:1 - 720 x 480 video

frame!

More information?

* *DVC "Blue Book"*

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* 1394 TA website

* Global DVC Club website

* DVC & Firewire central website

* Sequoia website

Sequoia Advanced Technologies

* Developer of IEEE-1394 consumer level system software specializing in Windows 95 and Windows NT

* Developed a high quality DVC codec for decoding and encoding DVC frames

* Has a full IEEE-1394 DV solution for Windows 95 and Windows NT

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